CLAIMS

1. A fuel cell power plant which uses water for operation, comprising:

an antifreeze mechanism (15, 16) for preventing freezing of water in the fuel cell power plant; and

a programmable controller (30) programmed to:

estimate a freezing probability of water in the fuel cell power plant after operation of the fuel cell power plant has stopped based on a parameter for estimating the freezing probability of water in the fuel cell power plant after operation of the fuel cell power plant stops (S13, S52);

estimate a wait time from when the power plant has stopped operating based on the freezing probability (S16, S56); and

suspend operation of the antifreeze mechanism (15, 16) until the wait time has elapsed from when the fuel cell power plant stops operating (S18-S20, S55, S58-S61, S62, S63).

2. The fuel cell power plant as defined in Claim 1, wherein the fuel cell power plant further comprises a sensor (2, 31) which detects a parameter for estimating the freezing probability of water in the fuel cell power plant after operation of the fuel cell power plant stops.

3. The power plant as defined in Claim 1 or Claim 2, wherein the controller (30) is further programmed to set the wait time to be shorter as the freezing probability increases (S13).

4. The power plant as defined in Claim 1 or Claim 2, wherein the fuel cell power plant further comprises a sensor (12) which detects the water temperature inside the fuel cell power plant, and the controller (30) is further programmed to set the wait time to be longer as the water temperature when the fuel cell power plant stops operating rises. (S13).

5. The power plant as defined in Claim 1 or Claim 2, wherein the controller (30) is further programmed to operate the antifreeze mechanism (15, 16) after the wait time has elapsed (S20, S63).

6. The power plant as defined in Claim 5, wherein the controller (30) is further programmed to update the freezing probability based on the parameter detected after the wait time has elapsed (S52), and operate the antifreeze mechanism (15, 16) only when an updated freezing probability exceeds a predetermined factor (S63).

7. The power plant as defined in Claim 6, wherein the controller (30) is further programmed, when the updated freezing probability does not exceed the predetermined factor, to recalculate the wait time based on the updated freezing probability (S56), re-update the freezing probability after the recalculated wait time has elapsed (S52), and operate the antifreeze mechanism (15, 16) only when the re-updated freezing probability exceeds the predetermined factor (S63).

8. The power plant as defined in Claim 7, wherein the controller (30) is further programmed to predict a variation characteristic of freezing probability from a variation of the estimated freezing probability in the past, and correct the re-updated freezing probability based on the variation characteristic (S52).

9. The power plant as defined in Claim 5, wherein the power plant comprises a water recovery mechanism (10, 14, 18, 20) which recovers and stores part of the remaining water when the power plant stops operating, and the controller (30) is further programmed to operate the water recovery mechanism (10, 14, 18, 20) before operating the antifreeze mechanism (15, 16) (S15, S62).

10. The power plant as defined in Claim 1 or Claim 2, wherein the antifreeze mechanism (15, 16) comprises a drain valve (15) which drains part of remaining water in the fuel cell power plant.

11. The power plant as defined in Claim 10, wherein the power plant further comprises a fuel cell stack (1) comprising an anode (1A) and a cathode (1B), a condenser (8) which condenses water vapor in cathode effluent discharged from the cathode (1B), a water tank (10) which recovers water condensed in the condenser (8), a humidifier (4) which humidifies gas supplied to the anode (1A), and a water passage (9B) which supplies water for humidification to the condenser (8) from the water tank (10), the antifreeze mechanism (15, 16) comprises a drain (16) which drains water from the water passage (9B), and

the drain valve (15) comprises a valve (15) which opens and closes the drain (16).

12. The power plant as defined in Claim 1 or Claim 2, wherein the antifreeze mechanism (15, 16) comprises a heater (13) which heats part of the remaining water in the fuel cell power plant.

13. The power plant as defined in Claim 1 or Claim 2, wherein the parameter comprises one of an outside air temperature and climatic data corresponding to a present location of the power plant.

14. The power plant as defined in Claim 2, wherein the sensor (2, 31) comprises a sensor (31) which detects a temperature outside the power plant as the parameter, and the controller (30) is further programmed to calculate the freezing probability based on the outside air temperature (S13, S52).

15. A freeze prevention method for a fuel cell power plant which uses water for operation and comprises an antifreeze mechanism (15, 16) for preventing freezing of water in the fuel cell power plant, the method comprising:

detecting a parameter for estimating a freezing probability of water in the fuel cell power plant after operation of the fuel cell power plant stops (S1);

estimating the probability of water freezing in the fuel cell power plant after operation of the fuel cell power plant has stopped based on the parameter (S13, S52);

estimating a wait time from when the power plant has stopped operating based on the freezing probability (S16, S56); and

suspending operation of the antifreeze mechanism until the wait time has elapsed from when the fuel cell power plant stops operating (S18-S20, S55, S58-S61, S62, S63).